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DEVELOPMENT OF ZEPPELIN AIRSHIPS
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U. S. G.A.X. GROUND ATTACK AIRPLANE
THE HANDLEY PAGE WING

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The Handley Page Wing

In a paper read before the Royal Aeronautical Society of the United Kingdom, Mr. Handley Page has finally given to the world the results of wind tunnel tests on the mechanism which has come to be known as the Handley Page wing

It would seem quite definitely established that by the use of slots in a wing the lift coefficient can be appreciably increased. With the later type of slot an R A F 6 section has had its lift increased some 50 per cent with the slots open, while the lift/drag coefficient of the same wing dropped from 16 6 to 14.1. For the R A.F 15 section an increase of 61 per cent in the lift was obtained, but the lift/drag ratio was spoilt at high speed angles Further results are expected from the effect of a number of slots, but it would already seem that the experiments are extremely promising The variation in lift obtainable by this system of slots seems to be far greater than that possible with variable camber arrangements. The variable camber increase of 25 per cent in the maximum lift is apparently all that can be expected

Although the mechanical difficulties of the Handley Page wing may be slightly greater than those obtained with variable camber, the enormous increase in lift achieved is bound to have a tremendous value in design and therefore warrants continued experimentation along this line

Reactive Propulsion Again

The subject of reactive propulsion has recently received a new impetus from the investigations conducted by various American, French and English inventors. The idea of using the explosive mixture to drive the airplane forward without the intermediary of pistons, connecting rods, crankshaft and propeller, has naturally its fascination in simplicity and ease However, the difficulties that will be encountered in practice along this line of thought are very great, for the efficiency of the combustible is very low if its speed is compared with that of the airplane

It is possible that by dragging in the surrounding air together with the combustible, the greater quantity of air at a lower speed might give the reactive propulsion system a greater efficiency However that be, it appears as if the subject would require a great deal of investigation and experimentation before practical fruition can be expected with any semblance of justification

Gasoline and Instrument Leads

It has recently been suggested that gasoline and instrument leads might well be carried outside the fuselage to the pilot's cockpit in single-engined airplanes, so as to secure maximum accessibility It is believed that this idea which has considerable practical possibilities, originated with Maj L. B Lent.

Everything that tends to simplify the overhauling of the power plant is of value to aircraft At the same time it would seem that in some cases the solution would be a clumsy one, with holes cut in the fuselage in conspicuous places and unnecessary bends and twists introduced in the leads. The value of this method would depend to a considerable extent on the merit of each particular design in which it would be incorporated.

Development of Military Aircraft

IN some recent issues of AVIATION AND AIRCRAFT JOURNAL there appeared some interesting information regarding the characteristics of the several new classes of war aircraft which the Engineering Division of the Air Service is studying with a view to their being made ready for production in a war emergency Among the newer types may be mentioned airplanes for night pursuit, armored ground pursuit, two-seater pursuit, all of which are necessitated by changed conditions of aerial warfare. Just as the early observation plane of 1914 brought about the creation of the fighter or pursuit airplane of 1915 for the purpose of preventing enemy observation, so the night bombers and armored ground attack airplanes of 1920 are now being countered by night pursuit and armored ground pursuit machines.

It is the old naval battle of heavy armor and gun fire against speed, mobility and light, specialized armament which is being reenacted in the air Just now the position in aerial armament seems in a state of flux Lessons are difficult to draw, mainly because the Great War ended at about the time new types of military aircraft, such as heavy bombardment, ground attack and night pursuit machines, were beginning to be employed. Their use was not, however, sufficiently continuous to lead to clearly visualized conceptions

For instance, there is still much controversy as to whether the day pursuit machine should be a single-seater or a two-seater The advocates of the single-seater point out its necessarily superior performance with respect to the two-seater, while the defenders of the latter emphasize the single-seater's total lack of protection against gun fire from the rear, all its guns pointing forward. Another instance, that of the armored ground pursuit machine, raises interesting and controversial points. As this type is to be used against heavily armored and gunned ground attack multi-seaters, machine gun fire will prove ineffective to do more than local damage; the ground pursuit machine must therefore also carry a cannon. But the weight of the latter together with that of the armor is so great that the fuel supply provides only for $1\frac{1}{2}$ hr flight and it may be questioned whether such a lack of cruising radius would not prove a serious handicap in fighting a foe who possesses armored ground strafers of considerable endurance. It would seem that, given the same armor and gun fire, more mobility would avail the armored ground pursuit airplane little if it is limited in its cruising radius.

The Development of Aircraft

With Special Reference to the Zeppelin Airships

By P. Jaray

Translated by Starr Truscott, Aeronautical Engineer, Bureau of Construction and Repair, Navy Department

All of the more recent surveys of the development of aircraft apparently regard the late war as the most important promoter of this development It cannot be overlooked however that advances in the construction of aircraft, as far as they relate to a product intended for attack and defense—that is as far as they trace back to constructions which are closely bound up with the demands which were made on aircraft as a weapon—have only a limited significance in the development of aircraft for transportation

For example, the essential qualities of military aircraft, great climbing ability, good maneuvering power and excessively high speed, play either no part or a minor one in transport aircraft Likewise those special constructions characteristic of fighting aircraft, which have caused them to develop in

FIG. 1 THE FIRST ZEPPELIN, LZ 1, [illegible] 1900

certain definite directions, form for transport aircraft experience which is partly useless and which today frequently implies only a hindrance, and in no case progress

Consequently in what follows the development of aircraft will be considered only from the point of view of its analysis as a means of travel or transportation without regard to its use as a weapon In concise form there will be presented the course which the development of aircraft has followed thus far, the stage it has now reached and what the prospects of further development appear to be In this there will appear a clear distinction between that of the airship, and that of the airplane.

Characteristics of the Development

To characterize the development it is convenient to use, in connection with the technical side, the non-dimensional coefficients derived from the general conditions of equilibrium and, in connection with the economic side a rating formula which, although by no means perfect and universal in its application, at least affords a basis for the estimation of economy

(A) Derivation of the Coefficients

These coefficients naturally may be stated from various points of view

In the *technical development* however the ratios of Propulsive Efficiency to Coefficient of Resistance and of Useful Load to Weight Empty, which have up to this time been most important in design work, must be regarded as the most important characteristics

If P is the propeller thrust in kilograms at a speed of v in meters per second, and at the normal engine r p m with corresponding power N in hp., then the efficiency η of the propeller and gearing is

$$\eta = \frac{Pv}{75N} \tag{1}$$

If ξ is the coefficient of resistance corresponding to a surface $J^{2/3}$ in sq meters (or a plane of area F in sq meters) and an air density of γ in kg per cubic meter, the resistance of an *airship* is

$$W_s = \xi_s \frac{\gamma}{g} J^{2/3} v^2 \tag{2}$$

or of an *airplane*

$$W_f = \xi_f \frac{\gamma}{g} F v^2 \tag{3}$$

(J = the volume of the airship)

For the condition of equilibrium

$$P = W \tag{4}$$

and we obtain

$$\frac{\eta}{\xi_s} = \frac{\gamma}{g} \frac{J^{2/3} v^3}{75N} \quad \text{for the airship} \tag{5}$$

and

$$\frac{\eta}{\xi_f} = \frac{\gamma}{g} \frac{F v^3}{75N} \quad \text{for the airplane} \tag{6}$$

This non-dimensional coefficient taken alone does not permit of a comparison of airship and airplane since the areas concerned $J^{2/3}$ and F are suitably chosen for practical reasons, but nevertheless arbitrarily It does show however in a remarkably clear manner, and within each of the two types of aircraft, the aerodynamic quality of the forms chosen for the parts offering resistance to the air, as well as the degree of efficiency of gearing and propellers.

A comparison between the aerodynamic coefficients of airships and airplanes may be obtained by the introduction of equivalent resisting surfaces even if such a comparison, in view of the different roles of the airship hull and airplane wing, is not entirely accurate As a matter of interest such a comparison will be made later, in which

$$\frac{\eta}{\psi} = \frac{\gamma}{g} \frac{f v^3}{75N} \tag{7}$$

will appear as an aerodynamic coefficient, in which ψ is the coefficient of resistance based on the projected area and f is this projected area in square meters (In the case of both airship and airplane the "projected area" means the area of the projection of all parts in the direction of motion)

The Ratio of Useful Load to Weight Empty as a specific Useful Load Carrying Ability θ is derived from the equilibrium condition

$$A = G + Q \tag{8}$$

in which A = Gross Lift
G = Weight Empty
Q = Useful Load

(All in kilograms or tons, metric)

From this by dividing through by G we obtain

$$\theta = \frac{Q}{G} = \frac{A}{G} - 1 \tag{9}$$

For airships

$$\theta_s = \frac{cJ}{g} - 1 \tag{10}$$

where c is the unit lift in kilograms per cubic meter, which for $0°C$ and 760 mm barometer, with mean moisture content and a specific gravity s (referred to air) of the inflation gas, has the value

$$c = 1.293\ (0.9986 - s) \tag{11}$$

(The figure 0.9986 corresponds to a mean relative humidity

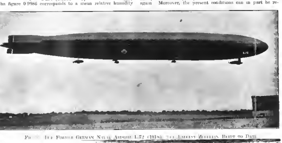


FIG. [illegible] THE FORMER GERMAN NAVAL AIRSHIP L 72 (1918) THE LARGEST ZEPPELIN BUILT TO DATE

of 0.60 at $0°C$ for inflation gas and air, and 760 mm barometer.)

For airplanes

$$A = \frac{\gamma}{g} \xi_a F v^2 \tag{12}$$

and hence

$$\theta_f = \frac{\gamma}{g} \frac{\xi_a F v^2}{G} - 1 \tag{13}$$

in which ξ_a is the special lift coefficient of the wings for the most economical flight.

From the two coefficients $\left(\frac{\eta}{\xi}\right)$ or $\left(\frac{\eta}{\psi}\right)$ and θ is derived a third most useful coefficient of comparison or figure of merit

$$\lambda = \frac{\eta}{\xi} \theta \tag{14}$$

or

$$\lambda' = \frac{\eta}{\psi} \theta \tag{15}$$

This originates from a somewhat arbitrary combination of two factors which hardly have a real relation to one another, but it makes it possible to show in a single expression the stages of development undergone by the aircraft in question from both the aerodynamic and structural point of view In the most extreme case it shows what is the greatest useful load which can be moved through the air using the smallest fixed weight with the best propulsive efficiency and smallest coefficient of resistance. In this it serves as a measure of the suitability of the forms and methods of construction chosen in building aircraft—consequently the degree of their technical perfection.

To symbolize the development from an *economic point of view* is much more uncertain, if not impossible It is obvious that one can express the degree of profitableness by a coefficient, which is the ratio of the possible income to the expenditures necessary in operation In this both qualities would apply to the same period Such a profit computation can be obtained mathematically only after very broad assumptions and simplifications Even then the difficulties would remain which are involved at present, partly by the uncertain monetary standard and partly by rising wages and prices.

In fixing upon the basic figures for the estimation of the profitableness it does not seem practical to refer to the wages and prices of 1914, as probably these will never be met with again Moreover, the present conditions can in part be regarded as not basic since many of the present prices have been forced up unnaturally high on account of the involved course of business For these reasons in the following deduction certain price equivalents will be assumed so that certain relations will follow, which can be assumed as probable in the future if no further depreciation occurs.

[The further progress of the currency depreciation—since the completion of the manuscript in the fall of 1919—makes the figures assumed for wages and costs appear too low in every case In reality however the absolute value of money has no internal effect on the results of the following investigation]

If Z is the per cent of time of actual operation of an aircraft in a given time (most conveniently per hour), k the rate per kilometer per ton of paying cargo, then the income per hour is

$$e = Z\,k\,L\ (V \pm W) \tag{16}$$

where L is the paying cargo in tons, V the air speed in kilometers per hour, W the velocity of the head wind in kilometers per hour, consequently $(V \pm W)$ is the ground speed.

To get an idea of the magnitude of Z it can be assumed that to keep an airship in commission—for repairs, housing, etc—about as much time is required as is actually occupied in flying On the basis of experience in operating the Zeppelin Bodensee Z_s would be set at 0.3 At that time the ship was the only ship of the Delag, and in the first two months of operation it made 75 trips averaging 6 hours duration or accomplished about 450 operating hours But the ship must be regarded as not utilized to the full, with respect to time, on account of the short trip chosen (Friedrichshafen-Berlin) and because it did this only once daily (although it could easily have returned on the same day in which case Z_s would have been 0.6) Consequently, and without being unduly optimistic, a value of Z_s = 0.5 can be safely assumed for later periods, when operation with several ships allows a balance in schedules.

With airplanes, however, night flying is entirely out of the question. Even with multi-engined machines emergency landings are necessary under some circumstances, which, with

the still imperfect methods of communication, might at night lead to accidents which would cripple aerial passenger traffic for a long period Of the remaining day time about half would be lost in preparations and maintenance work For this it is of course often possible to use in part the hours of bad weather conditions such as fog, heavy rain, and snow The unexpected occurrence of such weather might however interfere with scheduled flying time Consequently, under the most favorable conditions the value of Z_t can be taken = 0 2 Based on experience to date with regular aerial service—to be sure most imperfect—there would be obtained hardly the half of this figure so that with $Z_t = 0\ 2$ a substantial improvement of the flying service and its auxiliaries is assumed.

For ease of comparison the round figure of 10 marks is assumed as a rate per ton kilometer (This is about 2½ to 3 times the rate for first class express trains if one refers to rate for the same speed.) From this there results

$$\text{for airships} \quad e_s = 5L\ (V \pm W) \qquad (17)$$

$$\text{and for airplanes} \quad e_F = 2L\ (V \pm W) \qquad (18)$$

The *expenditures* per hour consist of (1) the amounts to be written off for the aircraft and its share of the shed and for the power plant with spare parts, (2) the salaries of officials and operating personnel, (3) the wages of laborers, helpers and landing parties, (4) the expenditures for repairs, maintenance, insurance, rents, advertising, etc. as well as (5) the cost of fuel

If these hourly expenditures are referred on the one hand to the power N of the aircraft in hp and on the other to the weight empty G in tons, there results—based on somewhat roughly estimated wages and costs—the figures given in the following table I.

TABLE I

Hourly Expenditures for	Airships	Planes
Written off for aircraft and its share of shed	4G Referred to	20 (to 30) $\frac{N}{1000}$
Written off for power plant and spare parts	25	10
Salaries for officers & operating personnel	20	10
Wages for labor, helpers, landing party	15	15
Expenditures for repairs, maintenance insurance rents, advertising etc	15	10
Fuel for	$Z_t = 0\ 8$	$Z_t = 0\ 2$
at 6 marks per kg & 240 gm per hp.	288	240
Gas at 1 mark per cu meter	120	0
Accidents and otherwise unprovided for	130	100
Total	803	400

Note The charges for rents of flying and landing fields are not included as they may be borne by the community Likewise a fixed return on the investment is not included as it can be assumed to be included in the Rating for Profitableness or Economic Coefficient.

From the foregoing table we obtain

$$a_s = 0\ 9N + 4G \qquad (19)$$

$$\text{and} \quad a_F = 0\ 4N + 2G \qquad (20)$$

With these assumptions (19 & 20) the economic coefficient then becomes

$$\text{for airships} \quad \omega_s = \frac{e_s}{a_s} = \frac{5L\ (V \pm W)}{0\ 9N + 4G} \qquad (21)$$

$$\text{or for airplanes} \quad \omega_F = \frac{e_F}{a_F} = \frac{2L\ (V \pm W)}{0\ 4N + 2G} \qquad (22)$$

NOTE More generally—dependent on the length of journey and rate.

$$a_s = (0\ 18 + 1\ 44Z)\ N + 4G \qquad (19\text{-a})$$

$$\text{and} \quad a_F = (0.16 + 1\ 20Z)\ N + 2G \qquad (20\text{-a})$$

$$\omega_s = \frac{Z\ k\ L\ (V \pm W)}{(0\ 18 + 1\ 44Z)\ N + 4G} \qquad (21\text{-a})$$

$$\text{and} \quad \omega_F = \frac{Z\ k\ L\ (V \pm W)}{(0\ 16 + 1\ 20Z)\ N + 2G} \qquad (22\text{-a})$$

It is to be noted that for comparison, the paying load L must be brought into proper relation to the useful load Q. Otherwise a shifting of the economic coefficient in favor of one or the other type of aircraft will occur because of the arbitrary distribution of the disposable weights From equations 21 and 22 there may be obtained, to begin with, the maximum economic coefficient for that aircraft which needs no fuel and no operating personnel, or carries only a very small quantity of fuel for the journey At present, development has not reached such a point that the useful load remains unaffected by the weight of crew and fuel Consequently, the cargo corresponds to what remains after the useful load has been diminished by the weights of fuel, officers, crew, reserve parts, stores and ballast Plainly, with the same expenses for stations and their personnel that aircraft will be the most economical which has to make the smallest number of landings to take on fuel, or, in other words, the one with the relatively greater radius of action On the other hand the economic coefficient grows directly with the paying cargo Therefore, the maximum in any case is reached if the weight of the fuel supply B is equal to the cargo L Therefore if

$$Q = L + B + T \qquad (23)$$

in which T is the total weight of the officers, crew, reserve parts, provisions and ballast, and

$$L = B \qquad (24)$$

$$\text{then} \quad L = \tfrac{1}{2}(Q - T) \qquad (25)$$

In this the following assumptions can be made for the weight T (in kilograms)

TABLE II

Weight of	Airship	Airplane
Officers	$20\sqrt[3]{I}$	$(160i-80)$
Crew	$180i$	
Spare Parts	$0\ 2N$	$0\ 1N$
Stores Ballast and Miscellaneous	$0\ 1I$	$0\ 01Q$

In this the number of engines is indicated as i which is dependent upon the power of the individual engines Ne so that

$$i = \frac{N}{Ne} \qquad (26)$$

Hence

$$L_s = \tfrac{1}{2}[Q - \frac{1}{1000}(20\sqrt[3]{I} + 0.1I + 100i + 0.2N)] \qquad (27)$$

Or

$$L_F = \tfrac{1}{2}[Q - \frac{1}{1000}(160i - 80 + 0\ 1N + 0\ 01Q)] \qquad (28)$$

And finally

$$\omega_s = \frac{2.5[Q - \frac{1}{1000}(20\sqrt[3]{I} + 0\ 1I + 160i + 0\ 2N)](V \pm W)}{0\ 9N + 4G} \qquad (29)$$

and

$$\omega_F = \frac{[Q - \frac{1}{1000}(160i - 80 + 0\ 1N + 0\ 01Q)](V \pm W)}{0\ 4N + 2G} \qquad (30)$$

NOTE Considered more generally similarly to eq (21-a) & (22-a)

$$\omega_s = \frac{Zk[Q - \frac{1}{1000}(20\sqrt[3]{I} + 0.1I + 160i + 0\ 2N)](V \pm W)}{2[(0.18 + 1.44Z)N + 4G]} \qquad (29\text{-a})$$

and

$$\omega_F = \frac{Zk[Q - \frac{1}{1000}(160i - 80 + 0\ 1N + 0\ 01Q)](V \pm W)}{2[(0.1E + 1\ 20Z)N + 2G]} \qquad (30\text{-a})$$

(To be continued)

New Tailspin Record

Declaring that his airplane made a total of twenty-eight revolutions in one minute and fifteen seconds in dropping from an altitude of 8,500 feet to 800 feet, George W Haldeman, former Air Service aviator claims he has broken the world's tail spin record The flight in which the drop occurred was made over Lakeland, Florida. The official tail spin record is 7,000 feet.

The Handley Page Wing *

By F. Handley Page

The present paper is a record of experimental work carried out with a view to overcoming the phenomenon of "burbling" As is well known, the total pressure on an aerofoil is the sum of the positive pressure on the underside and the negative suction on the upper If this negative suction can be made to increase progressively with increasing angle of incidence to angles greater than heretofore, the maximum value of the aerofoil lift coefficient will be increased. The effect of such an increase on airplane design depends upon the magnitude of the increase and the extra structure weight of the device necessary to obtain it The present method which is now described has been evolved from experimental data, and an outline of the results is given below

In a paper which I read before the Royal Aeronautical Society in April, 1911—ten years ago—I attempted an analysis of the somewhat meagre results then available on the pressures on plane and curved surfaces moving through the air. The effect now known as "burbling" was referred to as follows

"To obtain a law giving the normal pressure on a plane as a continuous function of the angle of incidence of the impinging air from 0 to 90 is impossible owing to the two distinct forms of flow that occur on the back of the plane From the horizontal position of the plane up to an angle varying in magnitude from 10 deg to 50 deg depending on the aspect radio, shape and curvature of the plane, the air hugs the back of the plane, the suction due to the rushing air is felt directly on the back of the plane, and the pressure increases continuously as some function of the angle At angles greater than this critical value the air leaves the back of the plane, a 'dead' air region is formed there, and any reduced pressure or suction on the plane back tending to increase the total 'lift' is then solely due to the drag of the 'live' air stream at the edges of this 'dead' air region"

A further reference was made later on in the paper

"The critical angle at which the 'live' air leaves the plane back is reached earlier in the case of planes of high aspect ratio, and the latter accordingly do not have such high maximum values as the planes of lower aspect ratio

"With planes of high aspect ratio there is not the same facility for the 'feeding in' of fresh air at the plane sides to act as a link between the plane and 'live stream', and therefore the 'live stream' leaves the plane back at an earlier stage than in the case of the plane of lower aspect radio"

In Fig 1 is the set of curves reproduced from the 1911 paper, showing the pressure on aerofoil as a function of the angle of incidence It will be observed that the square aerofoil marked P 1 1 continues lifting until 40 deg., whereas the aerofoil of aspect ratio 6.25 1 (marked L 6 25 1) "burbles" between 10 deg and 15 deg If, then, it were possible to convert the high aspect ratio aerofoil into a series of square ones and maintain the same conditions as in a square plane, higher maximum lift coefficients should be obtained.

Fig 2 is an aerofoil of aspect ratio 6¼ converted into six square planes by five slots, each parallel to the chord of the plane With the slots open the total "lift" on the plane was slightly increased and the "burble" took place at 14 deg instead of 13 deg (see Fig 3).

Improved results were later obtained with this form of slot, but this line of investigation was abandoned in favor of a transverse slot (see Fig 4), which was tested on an aerofoil of R.A F 15 section (see Fig 5) The shape of the slot, the width of the two openings and the position of the forward small aerofoil, and many other details, were found to have a very marked effect upon the results.

Fig 6 shows some early type slots of a R A.F 6 section, and Fig 7 the results obtained The lift coefficient increases about 25 per cent with the slot opened. Further developments are shown in Fig 8, where a simple single slot is formed by the swivelling front edge on aerofoil No 32, which was approximately of R A F 6 cross-section. This aerofoil was tested at the National Physical Laboratory at a speed of 80 ft. per second, and the results are shown in Figs 9 and 10 The maximum lift coefficient of the plane with the slot closed was 633 and with the slot open 943, an increase of 50 per cent The maximum value of the lift/drag coefficient was 16 6 and 14 1 respectively

These results have also been plotted in Fig 10, on curves showing the relation between speed and horse-power per lb weight, according to the method described in a paper which I read before the Aeronautical Society in March, 1917

Speed is plotted as $\frac{1}{\sqrt{Ky}}$, and horse-power per lb weight as $\frac{Kx}{Ky\sqrt{Ky}}$ With the slot open there is a reduction in landing speed of about 20 per cent, and with the slot closed practically all the advantages of the ordinary section

Similar Results with Various Aerofoils

So far the tests described have been on one particular kind of section, and further experimental work has been carried out showing that similar results may be obtained with any type of section, both on what may be termed a "high speed" section, such as R A F 15, or a "high lift" section, such as R A F 19 Fig 11 shows the R A F 15 section—51a and 51b—the section with the slot closed and the underside gap filled up being with a R A F 15 There is a slight difference between the two, 51a having the leading edge of the aft main aerofoil with a slight Phillips entry whereas 51b has the leading edge of the aft aerofoil on the chord line. The results are plotted in Fig 12, showing a slight improvement in lift in favor of 51b A comparison between the R A F 15 and this section with the slots open is also given on the curves. The maximum lift coefficient is increased from .52 to 84, an increase of 61 per cent, and the lift/drag ratio is higher with the slot open at all angles above 12 deg

The same general type of results were obtained with a thick section, such as R A F 19, a section of which is shown in Fig 13 with and without the slot, this aerofoil being No 44 As, however, the R A F 19 is a section of a small lift/drag ratio, the results of the single slot have not been included in this paper

An investigation of pressure distribution on the main and auxiliary aerofoils formed by the slot showed that the results obtained were of the same character as in an ordinary aerofoil, and that "burbling" would take place on the small auxiliary aerofoil when it was at its critical angle, just as an ordinary aerofoil would do without a slot It is evident that this can be overcome by further slots extending throughout the plane, and a series of experiments was accordingly carried out with various section, to determine the lift that would be obtained with a multiplicity of slots. In Figs 14, 15 and 16 the R A.F 19 is shown with two, three and seven slots, and a series of experiments was conducted with each number of slots from one to seven.

The results are plotted in Figs. 17, 18 and 19 With six slots the lift coefficient reaches the abnormal value of 1 96 at an angle of 45 deg., and in comparison the curve of R A F 16, which is also plotted on Fig 17, looks almost microscopic At the angle of inclination of 45 deg at which this large value of lift coefficient is obtained, the tangent of the trailing edge of the aerofoil is practically vertical, showing that the air is being deflected through the maximum angle possible and is leaving the plane practically in a vertical direction. Fig 18 shows the lift/drag plotted against lift coefficient, and Fig 19 the horse-power per lb weight against speed

These tests indicate that with a multiple slot arrangement and increase in lift coefficient can be obtained of two to three times the normal value without the slot

* Paper read before the Royal Aeronautical Society

Tests of Biplane Combinations

The tests so far described have all been monoplane tests, carried out in the wind tunnel at a speed of 40 ft per second. A further series of tests was carried out on several sections—of which aerofoil 42 is an example—to determine whether the same effect could be obtained on a biplane. The results in Fig 20 indicate that an increase in the lift coefficient of approximately 40 per cent was obtained with a single slot, and that a normal result was obtained. Further tests carried out since have clearly shown that with the necessary biplane corrections the slotted monoplane tests can be applied to biplane calculations.

Center of Pressure Tests

Aerofoil No. 42, the lift/drag coefficients for which have already been plotted in Fig 9 and 10, was tested for its center of pressure movement, and the results are plotted in Fig 23. At any given angle the center of pressure with the slot open is slightly farther back, but taking into account the decrease in lift coefficient at small angles with the slot open, for any given value of the lift coefficient the difference is not great. The general result, however, of the center of pressure line being slightly behind that of the normal position is one that might be anticipated as the pressure is more evenly distributed over the whole plane, and therefore the aft portion has a greater lift. This causes the result of the center of pressure to be farther back.

In commenting on the tests carried out on this section the National Physical Laboratory reported as follows:

"The high lift obtainable with the flap open is very remarkable especially in view of the fact that the position of the center of pressure is little altered. At the critical angle the C P is at 0.295 chord with flap open, which corresponds with its position at about 8 deg incidence with flaps closed. The longitudinal balance of the machine would be approximately the same when flying at 8 deg incidence or landing at 22 deg incidence, a very valuable characteristic. Scale effect in lift and drag are both considerable, but little effect on C P is found."

Flap Experiments with Slotted Aerofoil

An increase in the lift coefficient can be obtained by the use of a plane with flaps and by altering the angle of incidence of these flaps. A series of tests was carried out at the National Physical Laboratory, published in the report for the year 1913-14, pp 111 to 128. The results have been plotted in Fig 24 compared with aerofoil No 32 with the slot open and the slot closed. The R A F 19 curve shown is the envelope of the various curves, as plotted in Fig 32 of the report referred to above. The maximum lift coefficient on aerofoil No 32 is approximately .943, as against .62 with the flap, which at this value was set back at an angle of 60 deg. The increase in lift coefficient by the use of flaps can be obtained with the slotted plane as with the ordinary one. A series of tests was carried out on the section shown in Fig 25, and the results are plotted in Fig 26. With the plane inclined at 18 deg and 19 deg, a progressive increase in the lift coefficient is obtained, but at 20 deg and 21 deg the plane is inclined at the critical burbling angle, and owing to this results are somewhat unstable. Further experiments have determined that the rolling moments obtained with the alteration of the flap angle are of the same order as those on the plane of ordinary cross-section, indicating that full control can be obtained by ailerons in the ordinary manner when the slots are open.

Reference has already been made to pressure distribution plotting on a slotted plane. These experiments were carried out on aerofoil No 42, this being a R A F 15 section with an extra nosepiece added (Fig 27). The results are shown in Fig 28. The shape of these curves is very similar to that of the ordinary pressure plotting, except for the break in the curves where the slot is opened and the higher values in pressure obtained at the leading edge of the aft plane.

General Conclusions

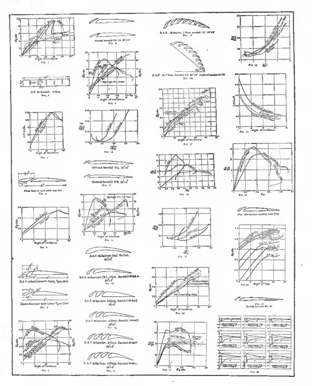
The record which has been given is one of progress in experimental work with the slotted plane. In general, the results show that depending upon the slot shape, position, width, inclination, etc., an increase in lift coefficient of from 40 to 60 per cent can be obtained with one slot, and up to 200 to 300 per cent, with a multiplicity of slots. The drag coefficient is slightly increased on the slotted plane with the slot closed, compared with an unslotted plane of similar cross section. The gap on the lower surface of the plane makes but little difference to the drag, but any discontinuity on the upper surface is at once attended by a large increase in the drag coefficient. With flaps fitted to such an aerofoil the necessary increases in lift coefficient can be obtained, so that the proper aileron control is still available. This is a distinct advantage over the method of increasing the lift coefficient by alteration of the flap angle, for with the flap at its maximum angle no aileron control is possible. The center of pressure is slightly aft of the position at smaller angles on a plane of similar section, but unslotted. This result is evident from an examination of the pressure plottings, which shows that distribution of pressure on each of the smaller constituent aerofoils while similar to an ordinary aerofoil, result in the lift being more evenly distributed over the plane.

Causes of "Burbling"

If reference is made once more to Fig 28, it will be seen that as the angle of incidence is increased, the pressure at the leading edge increases very rapidly. At 14 deg the negative suction on the upper surfaces of the plane reaches a value of 1.2 for both auxiliary and main aerofoils. After this point is reached, the auxiliary aerofoil's pressure increases more rapidly, reaching 1.65 at 16 deg and 2.2 at 18 deg. At 18 deg at abnormal pressure increase over the small area at the front edge of the auxiliary aerofoil is followed by a very rapid pressure drop, the pressure on the main aerofoil only reaching a value of 1.3. This very steep pressure graduation immediately results in "burbling", the maximum value of the pressure at 20 deg having fallen to 1.75. The same type of results is found with an ordinary plane, except that the rapid rise in pressure of the leading edge would have taken place at a smaller angle. To prevent "burbling" it is therefore necessary to ensure that the angle of the auxiliary planes is always kept sufficiently small, so that a rapid increase in pressure is possible, as has already been shown in the case of the R A F. 19 tests. It would appear that the rapid rise in pressure is due to abnormal velocity increase, with corresponding contraction of the live air stream, and that slightly farther back on the plane the necessary velocity reduction cannot be effected without setting up discontinuity and the eddying effects known as "burbling".

Effect on Design

The increase in lift coefficient possible with the slotted aerofoil permits either of slower running speeds than at present or alternatively, of less power at top speed. The first is self-evident; the second requires some explanation. In an aerofoil design with unslotted planes, the lift coefficient at top speed is usually less than that at which the best value of lift/drag is obtained. The landing speed and maximum lift coefficient determine the value of the lift coefficient at full speed, the drag at this latter speed—excluding body resistance for the moment—the horse power required to obtain this speed. With the slotted plane the reverse procedure may be adopted. The lift coefficient top speed can be chosen with reference to the best lift/drag ratio of the plane, and the slow speed for alighting obtained by the provision of the necessary number of slots to give the required lift coefficient. At top speed it will therefore now be possible to work at lift coefficients between .2 and .3 instead of the lower values which call for the use of a section such as R.A.F. 15 with low values of drag at very small angles. The trend of design would therefore be toward the choice of sections with high lift/drag ratio rather than fairly high lift/drag ratios at low values of the lift coefficient. If, then, machines can be designed with their planes at normal cruising speed, set at angles of incidence where the lift/drag ratio is not less than 16 and perhaps as high as 21 or 22, a great economy will be effected in the horsepower that is required. Economy does not, however, rest with the planes alone, for if the planes are more efficient it will pay to sacrifice a little weight to diminish the body resistance of the airplane. It



would appear from our recent experiments that a total lift/drag ratio on a complete airplane can be obtained of not less than 1 to 15 at the top speed. With this value and the propeller efficiency of 70 per cent, a speed of 120 m p h can be obtained with 33 lb per horsepower. It is evident that results such as these will emphasize the importance of improved methods of propulsion at slow speeds, so that the problem of arising with such heavy loads per horsepower is made easier that it would be at the present time.

The experimental results which have been given above have been confirmed by full-scale tests on a D H 9, the front edge of which was altered so that its section included a slot in front of the front spar. The increase in lift coefficient measured from the decrease in stalling speed showed that the full scale results followed closely the laboratory experiments.

Mechanical Devices Necessary

The operation of the auxiliary plane or planes to effect the transformation from slot closed to slot open does not present very great difficulties, nor does their addition to the structure lead to very much increase in weight. One of the simplest methods is by the simple swivelling of the front auxiliary portion, but in this device and in the actual methods of control many solutions are possible and experience in manufacture and operation can only indicate which is the best. It is to be hoped that the results which have been given above and the investigation which has been conducted will lead to further experiments being carried on elsewhere so that improved results may be obtained to the benefit of aircraft and aviation generally.

Canada's Air Ports

While the United States has done nothing, save locally in the matter of regulating air navigation, Canada has moved forward along the lines of the International Air Convention, which though signed by a representative of the American government, has not been ratified by the latter.

Customs "air harbors", where aircraft coming from abroad are required to land, have been established at Montreal, P Q (St Laurent Polo Grounds), Deseronto, Ont (Mohawk Indian Reserve), Toronto, Ont. (Armour Heights) and Virden, Man. These customs air ports are for airplanes only. It is expected that an additional customs air harbor for seaplanes will be established in the near future at Fredericton, N B

Civil Service Examinations
(Aeronautical)

The United States Civil Service Commission announces two competitive examinations, one for Chief Draftsman (aeronautical) and one for Mechanical Superintendent (Aircraft). One vacancy for each position mentioned, in the Naval Aircraft Factory, at $15.04 and $11.04 per day, respectively and vacancies in positions requiring similar qualifications at these or higher or lower rates of pay will be filled from these examinations.

Receipt of application to close on Apr 26, 1921. Further information may be had from the Civil Service Commission, Washington, D C

Mounting of Cameras in Airplanes

By Robert W. Elton

Chief Engineer Fairchild Aerial Camera Corp.

When the attempt was first made to install cameras in airplanes it was found that the vibrations caused by the motor or by the reactions of the frame of the plane due to the strains of flight seriously interfered with the taking of satisfactory pictures. The effect of this vibration were shown on the plates, in some cases by a multiple lines over the entire picture, or in others in sections of the picture being indistinct.

Eliminating Vibrations

This lead to the finding of means to overcome and eliminate the vibrations. The first remedy to suggest itself was the use either of rubber cushions or metal springs. There were quite a few different styles of mountings made, probably the first being a ring shaped frame set in the floor of the plane and lined with heavy sponge rubber. This, while it improved the pictures somewhat, did not do away entirely with the effects of the vibrations. The British army tried trays or cradles padded with sponge rubber and the French made a mounting using tennis balls for cushions. Later the French constructed a suspension set on bell cranks, rigidly linked together, with a frame at top and bottom, the camera being set upon the upper frame and the nose of it held by heavy rubber bands. This took care of the vertical vibration, but something was still lacking as the vibrations still showed to some extent.

At about this time the U S Air Service started a series of exhaustive experiments to determine just what was needed in order that the vibration could be eliminated. It was early found that as a first principle it was necessary that the camera should be supported at its approximate center of gravity and as a second, that it should rest on some elastic, beneath damping support. Various improvised mounts were made up on these principles and tried out, among the English method for testing, that is fastening electric lights to the tops of trees in a heavily wooded piece of land, and flying over them at the early evening at dusk, with the shutter wide open.

At the conclusion of these tests it was decided that to make a proper and satisfactory support it was necessary to include three principles. First, the camera would have to be supported at its center of gravity, second, the mount would have to be set on some substance that would give just the right amount of cushion, and third to derive some way of making the mount so that the camera could be tilted to compensate for the plane being out of parallel with the ground.

During the year 1918 such a mount was perfected for the U S Air Service by Lieut. J B Brinsmade and the writer, this mount being known as the Air Service Universal mount.

This mount consisted of two aluminum frames or supports whose ends rested on sponge rubber set in holders. This sponge rubber was of special composition and was put in the holders under just the right amount of pressure. These trusses supported a wooden gimbal ring which in turn supported a ring made of aluminum. The camera slipped into the aluminum ring. By the use of this mount the camera could not only be tilted to make it vertical with the ground at all times, but could also be tilted sidewise to allow of the taking of pictures at an oblique angle to the ground. It also allowed of the rotation of the camera to compensate for the crabbing of the plane.

Single Mount for Two Types of Camera

This mount was demanded for use with cameras of 20 in focus, which were then being used on account of the planes having to fly at a high altitude to avoid anti-aircraft guns. At the close of the war it was found that it was possible and more satisfactory to use a camera of 12-in focus for peace time work and that in order to use this mount it was necessary to weight the nose of the cone in order that the camera might still hang at its center of gravity.

This being very unsatisfactory, the new all metal mount was developed, constructed on the same principles but designed in such a manner that either the 12-in or the 20-in camera could be carried and the center of gravity maintained by the use of a simple adapter, thus doing away with the necessity of using weights.

This mount has recently been furnished the U S Army and Navy Air Services and is being put on the market by permission of the Government by the Fairchild Aerial Camera Corporation of New York.

"Who's Who in American Aeronautics"

Thurman Harrison Bane

BANE, THURMAN HARRISON Major, Air Service born San Jose Calif June 12 1884 son of Adam Clark Bane and Florence Cedonia (Harrison) Bane, married, Bessie Louise Dirkman May 29 1909

Educated Public Schools, including Lowell High School, San Francisco Calif | Graduate of U S Military Academy West Point 1907

Professional Commissioned as 2d Lieut. in the 14th Cavalry Promoted 1st Lieut. in 1912 Captain 1916 Major and Lt Col 1917 and Col early 1918 Just before America entered the World War (Mar 1917) was transferred from the 9th Cavalry to the Aviation Section of the Signal Corps with the rank of 1st Lieut. After ten years of service in the Cavalry, was first assigned to the Aviation School at San Diego Calif and later in charge of experimental work at the school. Promoted to Captain in June 1917, 1919 In Aug promoted to Major and assigned to Command of the ... ordered to Washington to act as Assistant to the Executive Air Division as a member of the examining board. Promoted to Lt Col in October; made a member of the Army and Navy technical aircraft board in charge of designs and specifications for aircraft. Next assignment was as executive officer of the Air Division and then as Chief of the Technical Section of the Bureau of Military Aeronautics. In Oct 1918 was ordered to Dayton O as Chief of the Technical Section on temporary duty with the Bureau of Aircraft Production at Dayton in charge of the work at Wilbur Wright Flying Field. In charge of that work until after signing of the armistice. Has since been Chief of the Engineering Division Air Service and Commanding Officer of McCook Field Dayton O

Flying Rating July 1917 Junior Military Aviator

War Honors: "Commander of the Order of the Crown of Italy" conferred by the King of Italy, May 10 1920

Member National Advisory Committee for Aeronautics Society of Automotive Engineers American Society of Mechanical Engineers

Present Occupation Chief Engineering Division Air Service and Commanding Officer of McCook Field

Address McCook Field, Dayton O

David Watson Taylor

TAYLOR, DAVID WATSON, Rear Admiral U S Navy born Louisa Co Va March 4 1864 son of Henry Taylor and Mary Minor (Watson) Taylor married Imogene Mary Morris Oct 26 1892

Educated At home until entered Randolph Macon College Ashland Va. 1885 U S Naval Academy Honorary Eng D Stevens Institute D Sc George Washington University

Professional Graduated Naval Academy 1885 Assistant Naval Constructor 1886 Graduated Royal Naval College Greenwich, England 1888 Naval Constructor 1892 Chief of Bureau Construction and repair 1914 to date

War Service Served as Chief of Bureau of Construction and Repair during World War Distinguished Service Medal Commander of Legion of Honor (French)

Books Resistance of Ships and Screw Propulsion (1893) "Speed and Power of Ships" (1910)

Member Army and Navy Club (Wash) Society of Naval Architects and Marine Engineers Institution of Naval Architects (British)

Present Occupation Chief Constructor U S Navy Chief of Bureau of Construction and Repair

Address Navy Department Washington D C home, 1913 19th St N W Washington D C

Walter Henry Phipps

PHIPPS, WALTER HENRY Aeronautical Engineer born Cleveland Ohio May 12 1892

Educated Public Schools of New York Institute Dr Schmitt, St Gallen Switzerland Stevens Institute Prep Hoboken N J resigned to enter aeronautics

Professional Designer and builder of airplanes since 1919

Aeronautical Activities: Student of Aviation since 1910 Designer of the M F P steel airplane 1914 Designer of 'Ordnance' military and sporting airplanes

Member Aero Club (N Y) Society Automotive Engineers (N Y)

Present Occupation Designer and Chief Engineer, Ordnance Engineering Corporation

Address Baldwin, Long Island N Y

Fiorello H. La Guardia

LA GUARDIA FIORELLO H. Lawyer born New York City, Dec 11 1882 Son of Achille and Irene La Guardia

Educated public schools Prescott Arizona, L L B New York University

Professional Practiced law in New York City deputy attorney general State of New York, 1915-1917 Member of Congress 65th and 66th Congresses, President Board of Aldermen New York City

Aeronautical Activities: First took up flying Mirafiori, Sept 1915—Bleriot Monoplane, 8th Aviation Instruction Center A E F American Bombing Detachment Italian Front

Flying Rating R M A War Service Major Air Service

War Honors War Cross (Italian) one citation Gen Diaz Knight Commander, Italian Crown

Member: New York Athletic Club, American Flying Many civic and political organizations.

Present Occupation: President, Board of Aldermen New York City

Address New York City

Lewis Edward Goodier, Jr.

GOODIER LEWIS EDWARD, Jr Captain U S Army born Utica N Y Aug 6 1885 son of Lewis Edward Goodier and Estelle (Northrup) Goodier married Myrtle Mahood Nov 29 1919

Educated Public schools, Utica, N Y Utica Academy Utica N Y, Central High School Washington D C Bachelor of Science in Engineering Chemistry 1908 Georgia School of Technology Atlanta Ga.

Professional Entered Coast Artillery Corps U S Army as 2d Lieut 1909 Transferred to Signal Corps for Aeronautical duty Sept 25 1912 with Aviation Section until July 1 1916 retired from active service as result of aero accident, July 1 1919; returned to active duty July 11 1919 returned to inactive duty list, May 20 1919 returned to active duty, Oct. 29 1920 Assistant Professor Military Science and Tactics Georgia School of Technology

Aeronautical Activities Student aviation officer Sept. 1912 to Feb 14, 1913 Instructor Signal Corp Aviation School June 1913 to June 1914 Commanding Officer 2d Company 1st Aero Squadron June 1914 to Nov, 1914 Badly injured accident Nov 5 1914 Inspection Section Aviation Section, July 1916 to April 1917

Flying Rating: Pilot's license Dec 25 1912 (No 200) Expert's License Feb 14 1913 Military Aviator Feb 14, 1913; Junior Military Aviator Aug 15 1914

War Service Organized and commanded Chandler Field, Essington Pa April 1917 to Nov 1917 Gerstner Field Lake Charles, La., Nov 1917 to April 1918 officer in charge operations section Office Director of Military Aeronautics Washington D C April 1918 to Aug 1918 Inspector Air Service S O S France Oct 1918 to Dec., 1918 Lt Col Oct 1917

Member Army and Navy Club (N Y) Army and Navy Club (Wash)

Present Occupation Assistant Professor Military Science and Tactics Georgia School of Technology

Address Georgia School of Technology, Atlanta Ga home, 28 Kimball Street Atlanta, Ga

Beckwith Havens

HAVENS, BECKWITH Aircraft Constructor, born New York City May 25 1890 son of A Brittor Havens and Livia (Beckwith) Havens.

Educated Public Schools of New York and California

Professional Automobile Salesman 1908 to 1910 Exporting motor Federal trucks 1914 Drr by 1914 to 1919 travelling over Europe Scandanavia, Australasia, South Sea Islands and the Orient

Aeronautical Activities Joined Glenn Curtiss in 1910 Exhibition pilot 1911-1919 Winner Great Lakes Race (Chicago-Detroit) 1913 and continued flight to New York holder of Curtiss Gold Medal and Aero Club Medal of Merit (1912); six months flying 1920 for Curtiss N Y Aircraft Corp

Flying Rating Aero Club of America license No 127 U S Naval Aviator No 124

War Service Lieut U S Naval Reserve Flying Corps

Member: Aero Club of America, New York Club Veteran Corps of Artillery and American Legion

Present Occupation Officer The Airships Mfg Co of America

Address: Hammondsport, N Y home, New York City

Byron Quinby Jones

JONES BYRON QUINBY Major Air Service born, Henrietta, Monroe County N Y, April 9 1888 son of Samuel Titus Jones and Sarah Minerva (Quinby) Jones married Evelyn Kennerly Clark June 4 1917

Educated Grammar School and High School Freshman year Mass. Inst of Technology 1912. Graduate of U S Military Academy Post Graduate Course in Aeronautical Engineering M I T

Professional Graduated from West Point 1912 served in 14th Cavalry to Nov 1913 Ordered to Air Service Nov 1913 Learned to fly in Signal Corps Aviation School San Diego Calif March and April, 1915 on duty at Brownsville Texas, with Lieut. Milling for the purpose of observing for the American forces at that place

Aeronautical Activities On duty with the First Aero Squadron in summer of 1915 and with detachment at Brownsville in Aug and Sept, 1915, On duty in Boston winter of 1915-1916 taking a course in aeronautical engineering on duty in Washington in connection with aviation activities with Pershing's expedition 1916-1917 in charge of all airplane repair shops and theoretical course of aeronautical instruction at San Diego Jan 1917 on duty in Washington on standardization of Army and Navy Air Service specifications July to Sept 1917; opened and organized the training school at Mt Clemens Michigan Oct 1917 on inspection about the country and Canada Nov 1917 made Chief of Air Service Training April to middle of June 1918 on duty in England and France in English French, and American training centers July to Dec 1918 on duty in connection with the proving testing of aviation equipment Oct to Dec directly in charge of the proving and testing at Wilbur Wright Field Fairfield Ohio Dec 1918 to May 1919 Engineering Representative in the Office of the Chief of Air Service Sept 1920 to date on duty as Assistant Chief of Supply Group

Flying Rating Junior Military Aviator 1914, Military 1917 Airplane Pilot, July 2 1920

Member Army and Navy Club (Wash)

Present Occupation Asst Chief of Supply Group, Office of Chief of Air Service

Address Munitions Building home, Army and Navy Club Washington D C

Arnold Norman Krogstad

KROGSTAD ARNOLD NORMAN Major Air Service born Lanesboro Minn Aug 28 1889, son of Christoffer O Krogstad and Nina B (Nelson) Krogstad married Julia LeGrand Revelle, Oct 6 1917

Educated High School Lanesboro Minn Graduated 1908 U S Military Academy

Professional 2d Lieut 1st Lieut and Captain U S Infantry

Aeronautical Activities Aviation Student at Signal Corps Aviation School San Diego Calif Oct. 1916 to May 1917 Officer of the U S Air Service to date

Flying Rating Junior Military Aviator 1917 Airplane Pilot 1920 Aero Club of America pilot license 1917

War Service Organized and Commanded Ground School at University of Calif and Rich Field at Waco Texas 1917 and 1918 Three months overseas as liaison officer 1918 1919, Operations Div Air Service

Member U S Infantry Association Army and Navy Air Service Association

Present Occupation In Command Aviation General Supply Depot, Morrison Va

Address Aviation General Supply Depot, Morrison Va.

Chalmers G. Hall

HALL, CHALMERS G Colonel Air Service, born Wilksboro N C Feb 8 1875 son of Philo Chalmers Hall and Elizabeth (Whiting) Hall married, Margaret McNeely, Feb 18 1909

Educated Public Schools of Hickory N C U S Military Academy

Professional Twelve years experience as army constructor for projects

Aeronautical Activities Organized four technical regiments for service in Air Service A E F Oct 18-July 18 In charge production and maintenance night bombardment Sector Air Service A E F Sept. 18 Feb 19 Chief Air Service Procurement, March 19 to date Chief Air Service Disposal Sept 19 to date; Experimental flying as observer only

War Service Spanish American War World War

Member Aero Club of America

Present Occupation Chief of Air Service Procurement Office of Director of Air Service

Address Munition Bldg home, 1814 17th St N W, Washington, D C

Laurence La Tourette Driggs

DRIGGS, LAURENCE LA TOURETTE Lawyer born Saginaw Mich Dec 1 1876 son of Laroy Channing Driggs and Mary (La Tourette) Driggs married Mary Ogden, June 20, 1904

Educated public schools Portland Ore A B University of Michigan 1899 L L D New York Law School 1900

Professional Practiced law in New York 1900-1913 as trial attorney for Brooklyn Heights Railroad Co Special Deputy Attorney General in trial of Fincian [illegible] member Moskri Commission frequently appointed receiver and trustee in bankruptcy by Federal Court bought and operated O [illegible] ranch in Texas 1913-1916 developed with Driggs Ordnance Co the Driggs one-pounder airplane gun 1916

Aeronautical Activities Taught to fly by Stevenson McGordon 1911 In Germany studying flying 1914 when war broke out began writing special articles on war aviation 1916 was guest of British Government as Aviation expert 1918 spent last six months of war as guest of the Allied Govts in the field including a cruise on the Grand Fleet Founded American Flying Club at the front and became its first president 1919 re-elected 1920 organized New York-Toronto Airplane race and Reid Trophy [illegible] 1919 Armistice Dinner Aviators Ball College Aviators race organized many branches of American flying clubs throughout the country Lectured on aviation in various cities and contributed articles on aviation in the leading magazines of the United States and England He had over 100 hours in the air and has flown in all types of airplanes in the United States and overseas Probably known more war aviators than any other person living

Books Eyes of the Army and Navy with Munday Arnold Adele American Ace Heroes of Aviation Fighting the Flying Circus with Rickenbacker Golden Book of Aviation Short Flights

Member American Flying Club, Apawamis Golf Chevy Chase Country (Wash) Arrkle Club (Reserve) Royal Air Force Club (London) Sons of Revolution Colonial Wars 1812 Society St Nicholas Huguenots Pilgrims various local Aviation Clubs

Address Home 20 Fifth Ave New York

Earl Larue Naiden

NAIDEN, EARL LARUE Major Air Service born Woodward Iowa Feb [illegible] 1894 son of Henry Richard Naiden and Cora [illegible] Naiden married Mary Frances Barnes Dec [illegible] 1919

Educated Woodward High School Iowa State College and U S Military Academy West Point

Professional Entered Cavalry [illegible] 1915 joined Aviation June 1916 Overseas [illegible] year and [illegible] months American Air Service Representative in Italy 1917 Served [illegible] general staff [illegible] H Q in G3 Section Instructor in Air Service [illegible] General Service Schools since 1919

Aeronautical Activities Made [illegible] Military Aviator March 1917 at San Diego [illegible] joined first Aero Squadron [illegible] April 1917 sailed with Squadron for France Aug 1917 trained in France Italy and later in the American schools in France First American pilot to qualify as a [illegible] pilot assigned as night bombing and [illegible] pilot served with French in night bombing squadron at front

Flying Rating Junior Military Aviator Cadillac Pilot [illegible]

War Record Army Air Service 21 months certificate of Merit by General Pershing and Officer of the Black Star [illegible] 1918

Books Air Service text book used in General service [illegible]

[illegible]

Present Occupation Instructor General Service [illegible] Air Service

Address 2 [illegible] Ft Leavenworth Kansas home Woodward Iowa

George Harrison Houston

HOUSTON, GEORGE HARRISON Industrial Engineer born Lexington Ky [illegible]

Educated public schools Lexington Ky Cincinnati Technical School

Professional Member of firm of George W Goethals & Co Inc specializing in industrial management 1916 through 1920 Vice President and General Manager Curtiss Aeroplane & Motor Corporation 1916 Pres Wright-Martin Aircraft Corporation 1917-1919 Pres Wright Aeronautical Corporation successor to Wright-Martin Aircraft Corporation from date of organization to present time

Aeronautical Activities In 1919 was member of Aviation Mission appointed by Secretary of War to study aviation in several countries of Europe

Member Engineers Club Aero Club of America Society of Automotive Engineers American Society of Mechanical Engineers

Present Occupation President Wright Aeronautical Corporation

Address 60 Broadway N Y home 270 West End Ave New York City

Arthur Read Christie

CHRISTIE, ARTHUR READ Major Air Service U S Army born East Orange N J July 29 1890 son of Arthur Wells Christie and Elizabeth Eline Christie married H de Beaume Jan 24 1920

Educated Columbia Grammar School East Orange High School New York Preparatory school College of William and Mary Williamsburg Virginia New York University (Law)

Aeronautical Activities As 2d Lieut Regular Army started training at Signal Corps Aviation School San Diego Calif Dec 1914 Passed J M A test June 1915 Original member of 1st Aero Squadron and served with this squadron at Fort Sill Oklahoma Brownsville Texas San Antonio Texas and in Mexico In August 1916 ordered to Chicago Ill to assist in organization of aviation school for reserve officers June 1919 appointed member Joint Army and Navy Board on Aeronautics and liaison Officer with naval air service

Flying Rating Military Aviator Aviator's Certificate No 323 Expert's Certificate No 40

War Service C O Signal Corps Aviation School Memphis Tenn C O Wilbur Wright Field Dayton Ohio C O 2nd Aviation Instruction Center Tours France C O 99th Aero Squadron C O 5th Army Corps Observation Group [illegible] of Air Service 5th Army Corps Toul Sector Vosges St Mihiel and Meuse-Argonne

Member Army and Navy (Wash) Pi Kappa Alpha and Phi Alpha Delta Fraternities Military Order of Foreign Wars

Present Occupation Commanding Officer Mitchell Field Long Island

Address Mitchell Field Mineola L I N Y

George Conrad Westervelt

WESTERVELT, GEORGE CONRAD Commander U S Navy born Corpus Christi Texas Dec 19 1879 son of G W Westervelt and Ida Florence Westervelt unmarried

Educated Corpus Christi Grammar and High Schools 1897 U S Naval Academy 1901 Master of Science Massachusetts Institute of Technology

Professional Entered Naval Service 1897 Graduated Naval Academy 1901 Entered Construction Corps 1904 Graduated Mass Inst of Tech 1906 Ships Construction and design and general Navy Yard experience until 1917 then Aeronautics to date

Aeronautical Activities Designed and built airplane 1911 General charge of production and inspection activities in field for Bureau Construction and Repair Apr 1 1917 to Nov 1 1919 Considerable flying in an observation capacity or under preliminary flight instruction

Flying Rating None at present Student aviator for year and a half but unable to take any consistent instruction

War Service General charge field inspection and production of aircraft for Bureau Construction and Repair during the war General charge design and building of NC boats and preparation for Transatlantic Flight member Joint Army Navy Aeronautical Commission to Europe 1917 Senior member Board of Investigation Naval Aero [illegible] 1918

Books Joint Author with Commanders Read and Richardson of "The Triumph of the NC's"—[illegible]

Member Army and Navy Club New York Yacht Club Racquet Club Philadelphia

Present Occupation Manager Naval Aircraft Factory Philadelphia Pa

Address Naval Aircraft Factory home Racquet Club Philadelphia Pa

Thomas G. Cassady

CASSADY, THOMAS G Bond salesman born Spencer Ind Dec [illegible] 1896 son of O K Cassady and Edith (Lauks) Cassady unmarried

Educated Spencer public and High schools University of Chicago

Aeronautical Activities Trained in French Schools of Aviation Tours Pau Plessis Belleville [illegible] 1917 to [illegible] 1917 went to French Escadrille Spad 157 Dec 1917 as Corporal in French Army Transferred to American Army April 1918 1st Lieut Returned to Spad 163 in Nov and served with the French until Sept 1918 then joined [illegible] Squadron 3d pursuit as Flight Com

War Service Served in Campaign 1917 Belfort Vosges 1917-1918 Chateau Thierry St [illegible] Meuse Campaign 1918 St Mihiel and Meuse Argonne

War Honors Discharged with rank of Captain Legion of Honor (French) Croix de Guerre with three palms and one Gold Star Distinguished Service Cross with Oak leaf Medal Aero Club of America

Member University Club (Minneapolis) Aero Club (Minneapolis)

Present Occupation Bond Salesman

Address Metropolitan Bank Bldg Minneapolis Minn

Albert Bond Lambert

LAMBERT, ALBERT BOND Manufacturer born St Louis Mo 1875 son of Jordan W Lambert and Lily (Winn) Lambert married Myrtle McGrew 1899

Educated 1895 University of Virginia

Professional Pres Lambert Pharmacal Co vice President Lambert Deacon Hull Printing Co Heath Mfg Co President, Paint, Oil & Drug Co

Aeronautical Activities Pres Aero Club of St Louis

Flying Rating Qualified Balloon Pilot Aero Club of France 1908 No 18 Qualified Aeroplane Pilot Aero Club of America 1911 No 61 Inducted Military Aeronaut

War Service U S Air Service Major Commanding Officer Army Balloon School San Antonio Texas

Books Balloon Physics

Member Pres Aero Club of St Louis Organized Mo Aeronautical Society Board of Directors Aero Club of America Pres Automobile Club of St Louis Pres Racquet Club Pres Glen Echo Country Club

Present Occupation Pres Lambert Pharmacal Co

Address 2101 Locust St St Louis Mo home 2 Hortense Place St Louis Mo

John Randolph Cautley

CAUTLEY, JOHN RANDOLPH Aeronautical Engine business born Richmond Va, Sept 2 1885 son of Richard Kingsman Cautley and [illegible] (Randolph) Cautley

Educated Began in log schoolhouse White Sulphur Springs W Va Continued in Maryland England France and Italy Prepared for college 9 years Baltimore Polytechnic Institute Baltimore Md Mechanical Engineer Cornell University Ithaca N Y

Aeronautical Activities 1909 Course in Aerodynamics Manchester Technical School Manchester England From that time until 1917 interested as hobby only Aug 1 1917 to date connected with Wright Martin Aircraft Corporation and Wright Aeronautical Corporation No flying experience except as passenger period of war Washington Representative of Wright Martin Aircraft Corporation

Books Technical articles for English and [illegible] papers

Member S A E A S M E Aero Club of America Cornell Club (N Y) Hamilton Club Paterson University Club and Bannockburn Golf Club (Wash) Hoonanknyd Country Club Suffern N Y

Present Occupation Sales Manager Wright Aeronautical Corporation

Address 238 Lewis St Paterson, N J home 100 East 17th St New York

William Adger Moffett

MOFFETT, WILLIAM ADGER Captain U S Navy born Charleston S C Oct 31 1869 Son of George Hall Moffett and Elizabeth (Simonton) Moffett married Jeannette Whitton July 26 1902

Educated public schools Charleston S C U S Naval Academy Annapolis Md

Professional Officer U S Navy

Aeronautical Activities Instituted and supervised Aeronautical Mechanics school at U S Naval Training Station Great Lakes, Ill Director for naval aviation U S Navy

War Honors Medal of Honor Distinguished Service medal

Member Army and Navy Club (Wash) Chevy Chase University (N Y) New York Yacht Club Onwentsia (Lake Forest Ill) Exmoor Country Club Chicago Athletic Association

Present Occupation Director of Naval Aviation

Address Navy Department Washington D C Home 1 [illegible] Q St N W

George William Lewis

LEWIS, GEORGE WILLIAM Engineer born Ithaca N Y March 10 1882 son of William H Lewis and Edith (Swallow) Lewis married Myrtle D Harvey Sept 9 1908

Educated Scranton High School M E 1908 M M E 1910 Cornell University

Professional Instructor Cornell University 1908-1910 Prof Engineering Swarthmore College 1910-1917 Eng in Charge Clarke Thomson Research, 1917-1919

Aeronautical Activities member of Committee on Power Plants for Aircraft of N A C A, 1918

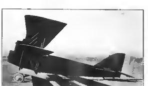
Books Report No 24 N A C A Air flow through poppet valves

Member American Society Mechanical Engineers and Society Automotive Engineers

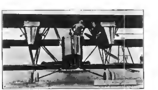
Present Occupation Executive Officer National Advisory Committee for Aeronautics

Address 3721 Navy Bldg Washington D C home 9509 Ridgewood Ave Chevy Chase Md

The U. S. G. A. X. Ground Attack Airplane



SIDE VIEW OF THE G A X AIRPLANE



FRONT VIEW OF THE G A X AIRPLANE, SHOWING ARMORED PORTIONS

Upon the completion of the contract for ten of the new U S Army Air Service model G A X ground attack airplanes let to the Boeing Airplane Co, the Army Air Service will have in operation its first armored strafing airplane This machine was built to the designs of the Engineering Division of the Air Service Following are the general characteristics

General Characteristics

The machine is generally of conventional design, with veneer fuselage from the rear of the gunners' cockpit. The forward section of the fuselage is armored as are the engines. The distinctive features of the machine are The "N" struts at an angle with the vertical to give the same over hang on all wing extremities, the pusher screws, and the armor and number of machine guns.

The machine is designed for one pilot and two gunners, operating eight machine guns and one cannon These three men are practically inclosed in armor, which, with the armor around the engines, weighs approximately 2,000 lb. The pilot in the forward cockpit operates one 37 mm cannon, a row of four Lewis machine guns shooting forward and downward, one machine gun shooting upward and over the wings. The gunners' cockpit has two Lewis guns shooting downward to the rear through a tunnel in the fuselage, and one shooting up and over the wings The airplane may be equipped also with sight and racks for ten bombs

General Dimensions

Overall span, upper wings, 65 ft 6 in., lower wings, 58 ft 6 in., maximum length, 33 ft 7 in., maximum height 14 ft 3 in

Wings

Chord, upper wing, 6 ft 8 in; intermediate and lower wings, 5 ft 8 in; gap between all wings, 5 ft. There is no dihedral in the upper wings, the intermediate wings are set at 1.5 deg., lower wings at 3 deg. The angle of incidence for all wings is 1.5 deg Sweep back, none, stagger none, total area, including area ailerons, 1016 ft

Ailerons

Ailerons are inserted in the upper and intermediate wings only The area of the ailerons in the upper wings is 36.8 ft and on the intermediate wings, 21.8 ft, 10 per cent of each of which is the balanced area The arrangement is the same on both planes. The operation is by the conventional Dep control.

Tail

This has an area of 55.3 ft The balanced elevators of 36.4 area are hinged to the rear of the stabilizer The rudder has an area of 45.8 ft, with a triangular fin

THREE-QUARTER REAR VIEW OF THE G.A.X. ARMORED AIRPLANE DESIGNED AND BUILT BY THE ENGINEERING DIVISION OF THE AIR SERVICE

Fuselage

The fuselage is of veneer, except on the forward armored portions, rectangular cross section varying from the maximum to a knife edge at the tail

Landing Gear

The chassis consists of a laminated spruce V strut under each nacelle, braced by a steel tube running from the axle to the center of the bottom of the armored body. Each unit carries two wheels. The weight of the two units complete is 358 lb., and the total weight of the airplane upon which the loading is based is 9820 lb

Power Plant

Engines, 2 Liberty-12, each of 435 hp., at 1800 r.p.m., Delco ignition, Zenith carburetor, drive direct, 4-bladed special propellers. The radiator in the nose of each engine nacelle is an Engineering Division type with shutters. There is a short exhaust pipe for each cylinder

Weights

Empty (inc. water)		7532 lb.
Useful Load		
Gasoline	615 lb	
Oil	60 lb	
Crew of 3	540 lb	
(Armament	933 lb	
(Reg. equipment		
Miscellaneous	60 lb	2208 lb.
Total weight fully loaded		9740 lb
Power loading	11.2 lb./hp	
Wing loading	9.6 lb./sq. ft	

Performance		In climb		In horizontal flight	
Altitude ft.	Time, min	Engine, r.p.m.	Climb, ft. min	Speed m.p.h.	Engine r.p.m.
000			600	107	1800
2000	3.7	1665	495	103.5	1780
4000	8.2	1660	390	102	1760
6000	14.1	1650	285	98.5	1735
8000	22.8	1635	185	95.0	1700
11500 (service ceiling)	36.1	1625	100	89.5	1665

Landing speed 50 m.p.h. Minimum speed 63.6 m.p.h. (at sea level).

Reserve Officers' Training Corps

The Reserve Officers' Training Corps was first organized in 1916 and since then the various Arms of the Service have established units at important colleges and universities throughout the country. The Air Service being the newest combatant Arm, was last to become established for it was not until November, 1920, that the Air Service R.O.T.C. Units were organized

A large number of leading colleges and universities of the country made application for the Air Service Units and the final recommendations were made with the following consideration in view. (a) Success of other R.O.T.C. Units already established at these universities. (b) General attitude of the institution. (c) Experience with Schools of Military Aeronautics during the World War. (d) Technical qualifications of institutions with particular reference to Aeronautical Engineering

Six units are now established and operating successfully with an Air Service officer in charge of the unit. These are: Texas Agricultural and Mechanical College, College Station, Texas, Major C. W. Russell, Massachusetts Institute of Technology, Cambridge, Mass., Captain Wm. B. Wright, Georgia School of Technology, Atlanta, Ga., Captain L. E. Goodier, Jr., University of Illinois, Urbana, Ill., Capt. John G. Whitesides, University of California, Berkeley, Cal., Major W. A. Robertson, University of Washington, Seattle, Wash., Major H. C. K. Muhlenberg

These are the pioneer units to make the way for more units which will be established during the course of the next few years.

A brief summary of War Department requirements for R.O.T.C. is as follows:

Students enrolling in an R.O.T.C. Unit when they enter an institution where a unit is established, enroll for two years' basic course which comprises three hours per week for two years. At the end of this time, they having successfully completed this two years' basic instruction, they may attend a basic training camp of six weeks' duration which, in the case of the Air Service is with an Infantry Unit. Students who have completed the first two years' basic course may enroll for two years' advanced instruction. At the end of the first years' advanced instruction a compulsory training camp of six weeks' duration is conducted. In the case of the Air Service this camp will usually be conducted at the Air Service Observation School, Post Field, Fort Sill, Okla., where students will receive practical instruction in the air and on the ground in Aerial Observation and general military subjects. At the end of the Senior year students who have successfully completed the Advanced Course may be commissioned as second lieutenants in the Reserve Corps; and in the Air Service, provided the necessary appropriations are available these Reserve Officers are immediately called to active duty for a period of six months. During this six months they receive three month's Advanced Training at an Air Service Special Service School and with a Service Squadron. This procedure will turn out an excellent quality of Reserve Officers for the Air Service and will give some material for regular commissions.

An estimate of the present total enrollments in Air Service R.O.T.C. units is approximately 526, based on incomplete reports. It is expected that less than 100 will attend the Basic Camp and that approximately thirty will attend the Advanced Camp during this summer

Schneider Cup Race, 1921

The annual race for the Jacques Schneider Maritime Aviation Cup will be held this year in Italy under the rules and regulations of the Aero Club of Italy between June 15 and Sept. 30. The date and place of the contest have not yet been set, but it is understood that, like last year, Venice will be selected.

This year's race promises to be a particularly lively one as Italian flying boats already carried off the honors twice in succession. In 1919, at Bournemouth, England, only the Italian contestant Guido Janello covered the whole course, the other entrants having been eliminated by various mishaps. He was unfortunate, however, in turning regularly around a wrong buoy instead of the turning marker provided and Italy therefore forfeited the victory, although the International Aeronautic Federation decided, with a view to recompensing Janello's moral victory, to let Italy organize the following cup race. This was held in the summer of 1920 at Venice and was won by Commander Bologna, of the Italian Navy, on a Savoia flying boat fitted with a 550 hp. Ansaldo-San Giorgio engine. Once more the Italian entrant was the only one to finish the race

Entries for the race will be accepted by the Aero Club of Italy until June 1, 1921. The inscription fee is 500 Lire. A deposit of 5,000 Lire must besides be paid by the entrants for each machine as a guarantee of their presence at the race. This deposit will be refunded for each machine present

Landing Field at Cincinnati

A landing field at Cincinnati, as an intermediate station in connection with the Aerial Mail Service between Pittsburg and St. Louis, if fully developed, would be one of the largest and best landing fields in the country, owing to its natural drainage which would permit its use the year round. It would be 2900 ft. north and south and 3000 ft. east and west and lies in a cross section giving a wide center. In addition there are 19 acres of land facing one of the best auto roads in the country. It has been estimated that for a small cost all necessary improvements could be made, but up to date nothing has been done.

Rules of Second Pulitzer Trophy Race

The Aviation Country Club of Detroit announces that the second race for the Pulitzer Trophy will take place at Selfridge Field, Mount Clemens, Mich., on Sept. 10, 1921. Preliminary trials of the contestants will be held from Aug. 31 to Sept. 6 at the same field, and an aviation meeting endowed with $10,000 in prizes will be held on Sept. 8 and 9, 1921. The meeting will be conducted under the rules and regulations of the F.A.I. and with the sanction of the Aero Club of America. Entries close on Aug. 1, 1921. Full particulars regarding entries, rules and prizes for the different events are given below. Further information and entry blanks may be obtained upon application to the Detroit Aviation Society, Inc., 4610 Woodward Ave., Detroit, Mich.

Event No. 1 Thursday, Sept. 8

TROPHY
CASH PRIZES

First Prize	$1500.00
Second Prize	750.00
Third Prize	250.00
Total	$2500.00

Conditions of Contest

RACE FOR LARGE CAPACITY MULTI-MOTORED AIRPLANES

(a) Factor of safety—monoplane—5 as loaded for start of race

biplanes—4 as loaded for start of race

(b) Air speed greater than 75 miles per hour

(c) Carrying contracted, specified or advertised loads.

Distance

Approximately 264 miles—four times around a closed course of approximately 66 miles, starting at Selfridge Field, passing over captive balloon located approximately 18 miles away, at approximately 6,000 feet altitude, thence to Aviation Country Club's Field, thence to Packard Field, and then returning to Selfridge Field

(a) *Start*

Starting signal will be given at 11 A. M. Airplanes to be on their allotted places on the Field at 10 A. M. Pilot's meeting for final instructions will be announced later.

(b) *Position at Start*

Planes competing for the ... Trophy will be sent away together in a flight, or series of flights, dependent on the number of entrants and conditions at time of start. However any entrants will be permitted to start alone after all flights, if this request is made to the Contest Committee in writing before Sept. 3rd, 1921.

(c) *Method of Start*

The Starter will assign an assistant starter to each plane, who shall raise the signal flags to and for its pilot, as follows: The starting signal (for motors only), a red flag, will be raised by the Chief Starter at 10.45 A. M. When the motor of each plane is running the assistant starter assigned to that plane will raise the red starting flag. When all assistants have raised the red starting flags, but not later than 11 A. M. the starter will raise, in addition to the red starting flag the white warning flag, which signifies that the getaway signal will be given in ten seconds, giving the mechanics time to draw the blocks from under the wheels. Each second will be counted by lowering the red flag, the getaway signal being the lowering of both red and white flags. If any contestant has difficulty in starting his motor, his assistant starter will not raise the red flag, but, when the Chief Starter raises the white warning flag, will raise a blue flag, which is a request for a deferred start. Deferred starts shall be granted without penalty, except that no plane will be allowed to start after a delay of one hour. Any plane having once started, cannot receive another start; however, it may complete the race, though forced down, provided it can do so before 5 P. M.

The Finish

The finishing time will be taken when each plane crosses the finishing line between the marks defining this line, after having completed the full course, approximately 264 miles.

Winner

The winner of first place shall be the pilot who has completed the full course in the shortest elapsed time, and second place, the second best time, etc., provided the pilot is not disqualified.

Qualifications

All pilots must hold an Aviator's license issued by the Federation Aeronautique Internationale and duly entered upon the Competitor's Register of the Aero Club of America.

Rules of the Race

(a) Pilots must hold a straight course after starting, until they have gone the distance to be specified and marked.

(b) A plane overtaken must hold its altitude and true course, in order that it may not in any way impede or interfere with a faster overtaking plane.

(c) A plane overtaking a slower plane shall never pass or attempt to pass between that plane and any pylon or captive balloon marking a turning point

(d) Pilots must attain the altitude of the captive balloon each lap, and in passing shall do so on either side in order that the observers in the basket may clearly see the airplane's number. Any pilot not having sufficient altitude upon reaching the ballon shall continue to climb, but must make a circle so that when passing the balloon the second time the airplane will be headed in the line of flight of the course.

(e) All pylons marking turning points must be passed at an altitude not greater than 400 feet.

(f) After crossing the finishing line, all planes shall continue on their course until they have attained the altitude of 2,000 feet, then they may turn and return to the field, and land in that part of the field assigned for landing and in so doing shall not cross the course or finish line.

(g) Any contestant breaking any of the foregoing rules of the course, or subsequent ones which may be officially announced in writing, shall upon recommendation of the judges be disqualified.

Protests

No protest shall be considered unless presented in writing to the Contest Committee of The Detroit Aviation Society, within twenty-four hours after the finish of the race.

Numbers

Each Airplane shall have a number assigned to it by the Contest Committee, painted on the bottom surface of the lower wing and on each side of the fuselage, clear of the wing in characters as large as possible. It shall have no other numbering or lettering over 12 inches in height.

No contestant shall be permitted to "dope" the fuel with picric acid, ether, or similar highly explosive liquids. Benzol and similar anti-knock fuels may be used

Event No. 2. Thursday, Sept. 8

TROPHY
CASH PRIZES

First Prize	$1500.00
Second Prize	750.00
Third Prize	250.00
Total	$2500.00

RACE FOR LIGHT COMMERCIAL AIRPLANES

Conditions of Contest

(a) Factor of safety—monoplanes—5 as loaded for start of race

biplanes—4 as loaded for start of race.

(b) Air speed greater than 80 miles per hour

(c) Arranged to seat three or more passengers including pilot and carrying their capacity load, 160 lbs. of ballast must be carried in place of each passenger omitted.

Distance

Approximately 264 miles—four times around a closed course of approximately 66 miles, starting at Selfridge Field, passing over captive balloon located approximately 18 miles away at approximately 6,000 feet altitude, thence to Aviation

Country Club's Field, thence to Packard Field, and then returning to Selfridge Field.

(a) *Start*

Starting signal will be given at 11 30 A M. Airplanes to be on their allotted places on the Field at 10 A M. Pilot's meeting for final instructions will be announced later

(b) *Position at Start*

Planes competing for the .. . Trophy will be sent away together in a flight, or series of flights dependent upon the number of entrants and the conditions at the time of start However, any entrant will be permitted to start alone after all flights if this request is made to the Contest Committee in writing before September 3ed, 1921.

(c) *Method of Start*

The Starter will assign an assistant starter to each plane, who shall raise the signal flags to and for its pilot as follows: The starting signal (for motors only) a red flag will be raised by the Chief Starter at 11 15 A M When the motor of each plane is running the assistant starter assigned to that plane will raise the red starter flag When all assistants have raised the red starting flags, but not later than 11 30 A M the Starter will raise, in addition to the red starting flag, the white warning flag, which signifies that the getaway signal will be given in ten seconds, giving the mechanics time to draw the blocks from under the wheels. Each second will be counted by lowering the red flag, the getaway signal being the lowering of both red and white flags. If any contestant has difficulty in starting his motor, his assistant starter will not raise the red flag, but when the Chief Starter raises the white warning flag will raise a blue flag, which is a request for a deferred start Deferred starts shall be granted without penalty, except that no plane will be allowed to start after a delay of one hour. Any plane having once started, cannot receive another start, however, it may complete the race, though forced down provided it can do so before 5 30 P. M.

The Finish

The finishing time will be taken when each plane crosses the finish line between the marks defining this line, after having completed the full course, approximately 264 miles.

Winner

The winner of the first place in the race proper shall be the pilot who has completed the full course in the shortest elapsed time and second place, the second best time, etc , provided the pilot is not disqualified

Qualifications

All pilots must hold an Aviator's license issued by the Federation Aeronautique Internationale and duly entered upon the Competitor's Register of the Aero Club of America

Rules of the Race

(a) Pilots must hold a straight course after starting, until they have gone the distance to be specified and marked.

(b) A plane overtaken must hold its altitude and a true course, in order that it may not in any way impede or interfere with a faster overtaking plane

(c) A plane overtaking a slower plane shall never pass or attempt to pass between that plane and any pylon or captive balloon marking a turning point.

(d) Pilots must attain the altitude of the captive balloon each lap, and in passing shall do so to either side in order that the observers in the basket may clearly see the airplane's number. Any pilot not having sufficient altitude upon reaching the balloon shall continue to climb, but must make a circle so that when passing the balloon the second time the airplane will be headed in the line of flight of the course.

(e) All pylons marking turning points must be passed at an altitude not greater than 400 feet

(f) After crossing the finishing line, all planes shall continue on their course until they have attained the altitude of 2,000 feet, then they may turn and return to the Field, and land in that part of the Field assigned for landing and in so doing shall not cross the course or finish line

(g) Any contestant breaking any of the foregoing rules of the course, or subsequent ones which may be officially announced in writing, shall upon recommendation of the judges, be disqualified

Protests

No protest shall be considered unless presented in writing to the Contest Committee of the Detroit Aviation Society, Inc., within twenty-four hours after the finish of the race.

Numbers

Each airplane shall have a number assigned to it by the Contest Committee, painted on the bottom surface of lower wing and on each side of the fuselage, clear of the wing, in characters as large as possible. It shall have no other numbering or lettering over 12 inches in height

No contestant shall be permitted to "dope" the fuel with picric acid, ether, or similar highly explosive liquids. Benzol and similar anti-knock fuels may be used.

Conditions of Trials

Trials for slow speed landing, take-off and greatest range of speed—also the examination for bonuses given for self-starter, muffler and accessibilty to oil, water, gas filling caps, draining plugs and filtering screens, ignition breakers and distributors, will be conducted from August 31st to September 6th, 1921

Any contestant failing to make these trials during the period shall, at the discretion of the Contest Committee, forefeit the rights to the points which he may have gained—even though the trials are made after the race

This trophy and cash prizes are to be awarded on points given as follows

(a) To the winner of the race proper . 000 points.

To those finishing within twenty minutes of the winner their pro rata share of points on the basis of 30 points per minute.

(b) For the greatest range of speed . 250 points.

The time to be figured by deducting the time it would take an airplane to fly one-quarter of the distance of the race at its lowest speed (this to be determined in advance by trial flights in both directions over a measured course with throttled motor) from the time in which this airplane actually completed the race To those coming within fifteen minutes of the speed range winner, their pro rata share of points on the basis of 16 66 points per minute

(c) For the shortest take-off . . 100 points.

To those taking-off within 100 feet of the winner, their pro rata share of points on the basis of one point per foot

(d) For the shortest run after touching wheels when landing . .. .. 100 points.

To those stopping within 100 feet of the winner, their pro rata share of points on the basis of 1 point per foot.

(e) A bonus of fifty points will be given to each airplane carrying an operative self-starter

(f) A bonus of fifty points will be given to each airplane carrying a muffler which effectively muffles the motor at a height of 1500 feet, in normal flight

(g) A bonus of fifty points will be given to each airplane having complete accessability to the following

Spark plugs, oil, water, gas filling caps, draining plugs and filtering screens, ignition breakers and distributors.

Note that any airplane failing to complete the race is not entitled to the points given for range of speed, as the element of reliability is embodied in this event.

In the event of a tie in the scores of two airplanes, the airplane having received the greatest number of points in the race shall receive an extra point

Event No 3. Friday, Sept 9

TROPHY

CASH PRIZES

First Prize	$1500 00
Second Prize	750 00
Third Prize	250 00
Total	$2500 00

RACE FOR OBSERVATION TYPE (2 PASSENGER) AIRPLANES

Conditions of Contest

(a) Factor of safety—monoplane—5 as loaded for start of race

biplanes—4 as loaded for start of race

(b) Air speed greater than 90 miles per hour

(c) Carrying U S Government specified load for this type of airplane

Distance

Approximately 264 miles—four times around a closed course of approximately 66 miles, starting at Selfridge Field, passing over captive balloon located approximately 18 miles away at approximately 6,000 feet altitude, thence to Aviation Country Club's Field, thence to Packard Field, and then returning to Selfridge Field.

(a) *Start*

Starting signal will be given at 11 A. M Airplanes to be on their allotted places on the Field at 10 A M. Pilot's meeting for final instructions will be announced later.

(b) *Position at Start*

Planes competing for the . Trophy will be sent away together in a flight, or series of flights dependent upon the number of entrants and the conditions at the time of start However, any entrant will be permitted to start alone after all flights if this request is made to the Contest Committee in writing before September 3rd, 1921.

(c) *Method of Start*

The Starter will assign an assistant starter to each plane, who shall raise the signal flags to and for its pilot as follows The starting signal (for motors only) a red flag will be raised by the Chief Starter at 10 45 A M When the motor of each plane is running the assistant starter assigned to that plane will raise the red starting flag When all assistants have raised the red starting flags, but not later than 11.00 A M the Starter will raise, in addition to the red starting flag, the white warning flag, which signifies that the getaway signal will be given in ten seconds, giving the mechanics time to draw the blocks from under the wheels Each second will be counted by lowering the red flag, the getaway signal being the lowering of both red and white flags. If any contestant has difficulty in starting his motor, his assistant starter will not raise the red flag, but, when the Chief Starter raises the white warning flag, will raise a blue flag, which is a request for a deferred start Deferred starts will be granted without penalty, except that no plane will be allowed to start after a delay of one hour. Any plane having once started, cannot receive another start; however, it may complete the race, though forced down, provided it can do so before 5 00 P M

The Finish

The finishing time will be taken when each plane crosses the finish line between the marks indicating this line, after having completed the full course, approximately 264 miles.

Winner

The winner of first place in the race proper shall be the pilot who has completed the full course in the shortest elapsed time, and second place, the second best time etc., provided the pilot is not disqualified.

Qualifications

All pilots must hold an Aviator's license issued by the Federation Aeronautique Internationale and duly entered upon the Competitor's Register of the Aero Club of America.

Rules of the Race

(a) Pilots must hold a straight course after starting, until they have gone the distance to be specified and marked

(b) A plane overtaken must hold its altitude and a true course, in order that it may not in any way impede or interfere with a faster overtaking plane

(c) A plane overtaking a slower plane shall never pass or attempt to pass between that plane and any pylon or captive balloon marking a turning point.

(d) Pilots must attain the altitude of the captive balloon each lap, and in passing shall do so to either side in order that the observers in the basket may clearly see the airplane's number Any pilot not having sufficient altitude upon reaching the balloon shall continue to climb, but must make a circle so that when passing the balloon the second time the airplane will be headed in the line of flight of the course.

(e) All pylons marking turning points must be passed at an altitude not greater than 400 feet.

(f) After crossing the finishing line, all planes shall continue on their course until they have attained the altitude of 2,000 feet, then they may turn and return to the Field, and land in that part of the Field assigned for landing and in so doing shall not cross the course or finish line.

(g) Any contestant breaking any of the foregoing rules of the course, or subsequent ones which may be officially announced in writing, shall upon recommendation of the judges, be disqualified.

Protests

No protest shall be considered unless presented in writing to the Contest Committee of the Detroit Aviation Society, Inc., within twenty-four hours after the finish of the race.

Numbers

Each airplane shall have a number assigned to it by the Contest Committee, painted on the bottom surface of lower wing and on each side of the fuselage, clear of the wing, in characters as large as possible; it shall have no other numbering or lettering over 12 inches in height.

No contestant shall be permitted to "dope" the fuel with picric acid, ether, or similar highly explosive liquids Benzol and similar anti knock fuels may be used

Conditions of Trials

Trials for slow speed landing, shortest take-off and greatest range of speed will be conducted from August 31st to September 6th, 1921, inclusive.

Any contestant failing to make these trials during this period shall, at the discretion of the Contest Committee forfeit the rights to the points which he may have gained—even though the trials are made after the race

This trophy and cash prizes are to be awarded for points given as follows

(a) To the winner of the race ....450 points.

To the airplanes finishing within fifteen minutes of the winner, their pro rata share of points on the basis of 30 points per minute.

(b) For the greatest range of speed ....250 points

The time referred to below to be figured by deducting the time it would take an airplane to fly one-quarter of the distance of the race at its slowest speed (this to be determined in advance by trial flights in both directions over a measured course with throttled motor) from the time in which this airplane actually completed the race. To those coming within fifteen minutes of the speed range winner, their pro rata share of points on the basis of 16 66 points per minute.

(c) For the shortest take-off .... 100 points.

To those taking-off within 100 feet of the winner, their pro rata share of points on the basis of 1 point per foot.

(d) For the shortest run after touching wheels when landing ....100 points.

To those stopping within 100 feet of the winner, their pro rata share of points on the basis of 1 point per foot.

Note that any airplane failing to complete the race is not entitled to the points given for range of speed, as the element of reliability is embodied in both of these events.

In the event of a tie in the scores of two airplanes, the airplane having received the greatest number of points in the race shall receive an extra point.

Event No. 4. Saturday, Sept. 10

PULITZER TROPHY

CASH PRIZES

First Prize	$1500 00
Second Prize	750 00
Third Prize	250 00
Total	$2500.00

FREE-FOR-ALL RACE FOR HIGH SPEED AIRPLANES

Conditions of Contest

(a) Factor of Safety—monoplanes—$7\frac{1}{2}$ as loaded for start of race.

biplanes—6 as loaded for start of race.

(b) Air speed greater than 140 miles per hour, as loaded for start of race.

(c) Visibility and maneuverability (land and air) which in opinion of Contest Committee is not a menace to the other contestants or spectators.

Distance

Approximately 160 miles, four times around a closed course of 40 miles, from Selfridge Field, thence west to captive balloon, thence to Packard Field and return to Selfridge Field.

Start

The starting signal will be given at 11 A. M. Airplanes to be on their allotted places on the Field at 10 A. M. Pilot's meeting for final instructions to be announced later.

(b) *Position at Start*

Planes competing for Pulitzer Trophy will be sent away separately.

(c) *Method of Start*

Starting time will be taken when plane crosses starting line between marks defining this line

(d) No contestant shall start before he receives the getaway signal

(e) Any contestant, having once started, cannot receive another start. However, he may complete the race, if forced down provided he can do so before 3 P M

The Finish

The finishing time will be taken when each plane crosses the finish line between the marks defining this line, after having completed the full course of approximately 160 miles

Winner

The winner of the first place shall be the pilot who has completed the full course in the shortest elapsed time, and second place, the second best time, etc. provided the pilot is not disqualified

Qualifications

All pilots must hold an Aviator's license issued by the Federation Aeronautique Internationale and duly entered upon the Competitor's Register of the Aero Club of America

Rules of the Race

(a) Pilots must hold a straight course after starting, until they have gone the distance to be specified and marked.

(b) A plane overtaken must hold its altitude and a true course, in order that it may not in any way impede or interfere with a faster overtaking plane.

(c) A plane overtaking a slower plane shall never pass or attempt to pass between that plane and any pylon or captive balloon marking a turning point.

(d) After crossing the finishing line, all planes shall continue on their course until they have attained the altitude of 2,000 feet, then they may turn and return to the Field, and land in that part of the Field assigned for landing and in so doing shall not cross the course or finish line.

(e) Pilots shall pass all turning points in plain view of the observing officials stationed at each turning point and at an altitude of not over 500 feet.

Any contestant breaking any of the foregoing rules of the race, or subsequent one which may be officially announced in writing, shall, upon recommendation of the judges be disqualified.

Protests

No protest shall be considered unless presented in writing to the Contest Committee of the Detroit Aviation Society, Inc, within twenty-four hours after the finish of the race.

Numbers

Each airplane shall have the number assigned to it by the Contest Committee, painted on the bottom surface of lower wing and on each side of the fuselage, clear of the wing, in characters as large as possible. It shall not have other numbering or lettering over 12 inches in height.

All airplanes may compete with pilot only

No contestant shall be permitted to "dope" the fuel with picric acid, ether, or similar highly explosive liquids. Benzol and similar anti-knock fuels may be used

Torsion of Wing Trusses at Diving Speeds

N A C A, Report No. 104

It is the purpose of this report to indicate what effect the distortion of a typical loaded wing truss will have upon the load distribution. The case of high angle of incidence may be dismissed immediately from consideration as the loads on the front and rear trusses are nearly balanced, and consequently there will be little angular distortion. A given angular distortion will have the maximum effect upon load distribution in the region of the angle of no-lift, because the slope of the lift curve is highest here, and it is here that the greatest angular distortion will occur, because the load on the front truss acts downward while the load on the rear truss acts upward

The RAF-15 aerofoil was chosen as most typical of present day wing sections and serves for an illustrative example. This was combined with JN-4 wing truss, a biplane with overhanging upper wings. Starting with the assumption of a loading for a rigid structure the wing truss and the deflections were calculated. The assumption of loading for the second trial was based upon the deflections as determined by the first trial After several approximations it was possible to compute accurately the angular distortion at each panel point.

It was found that no great angular distortion occurred at panel points where there was adequate stagger bracing but that it was considerable at the tip of the overhanging portion of the upper wing In conclusion, it may be said that it is not worth the added complication to correct the load distribution on the conventional biplane for wing truss distortion but that it would be highly advisable in the case of a monoplane, where the wires of the lift truss make an acute angle with the spars and where there can be nothing to take the place of stagger bracing It would also be advisable in the case of the internally braced wing where the relative deflection is likely to be high

A copy of report No 104 may be obtained from the National Advisory Committee for Aeronautics, Washington, D C., upon request

Effects of Varying the Number of Plies in Plywood

In making up plywood for a particular use the question frequently arises, should three plies or more than three be used to obtain the required thickness? Some data from tests by the U S Forest Products Laboratory may be of assistance in answering this question

An increase in the number of plies results in a decrease in the tensile and bending strength parallel to the grain of the faces and an increase in the corresponding strength at right angles to the grain of the faces

If the same bending or tensile strength is desired in two directions, parallel and perpendicular to the grain of the faces, the greater number of plies the more nearly the desired result is obtained. It must be borne in mind, however, that plywood with a large number of plies, while stronger at right angles to the grain of the faces, can not be so strong parallel to the grain of the faces as three-ply wood, and hence a three-ply panel is preferable where greater strength is desired in one direction than in the other

Where great resistance to splitting is necessary, as in plywood that is fastened along the edges with screws and bolts and is subjected to forces through the fastenings, a large number of plies affords a better fastening

It is common experience that a glued joint is more likely to fail when thick laminations are glued with the grain crossed than when thin laminations are glued The same weakness exists in plywood when thick plies are glued together. When plywood is subject to moisture changes, stresses in the glued joint due to shrinkage are greater for the thick plies than for the thin plies. Hence in plywood constructed with many thin plies the glued joints will not be so likely to fail as in plywood constructed with a smaller number of thick plies.—Technical Note No 132, Forest Products Laboratory

Air Service Reorganization Policy

Corps area commanders were notified by the War Department on March 3 that the size of the Air Service and the number of its various units were so unbalanced as to demand that the National Guard and the Organized Reserves be considered with the Regular Army in order to secure coordinated effort in the organization and operation of the Air Service as a whole. Economy and efficiency, says a War Department statement, issued at the direction of Secretary Baker make it desirable to have so far as practicable, only one system of airdromes, supply depots and repair depots for the three components of the Air Service, viz., the Regular Army, the National Guard and the Organized Reserves. A plan for the distribution and location of Air Service units for the three component parts is now in preparation and will be issued soon to serve as a guide. While the location of the National Guard units within a given state is, by Sec. 68, act of June 4, 1920, vested in the state, the War Department desires that the boards of officers appointed to locate these units give careful consideration to the coordination plan referred to and assign units to the locations therein given so far as is compatible with local and other conditions within the state.

Aircraft and National Defense

Many ill-informed statements upon the relation of aircraft to National Defense are current. These react unfavorably upon the public and our legislators and tend to cloud vital questions of national policy.

A recent instance of this followed the storm created in army, navy and aviation circles by Brig.-Gen. William Mitchell's able testimony upon the effectiveness of bombing and torpedo planes against surface ships.

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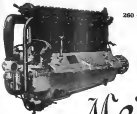

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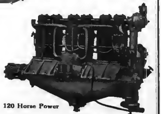

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